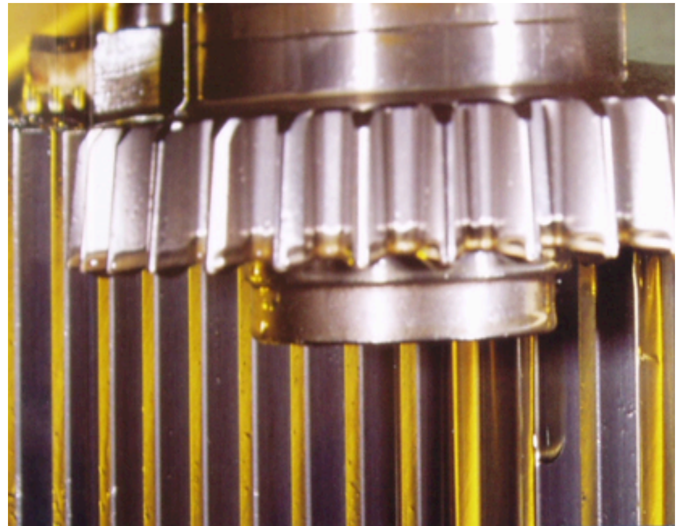
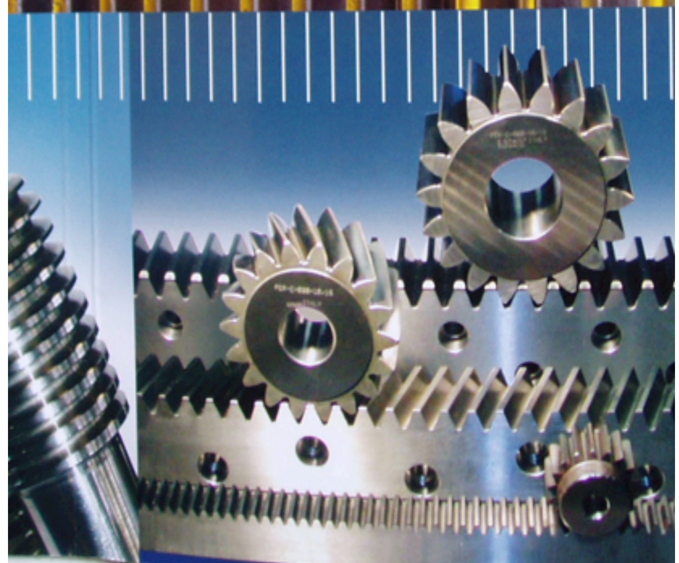




Engenharia
Mecânica
Politécnica - COPPE
UFRJ

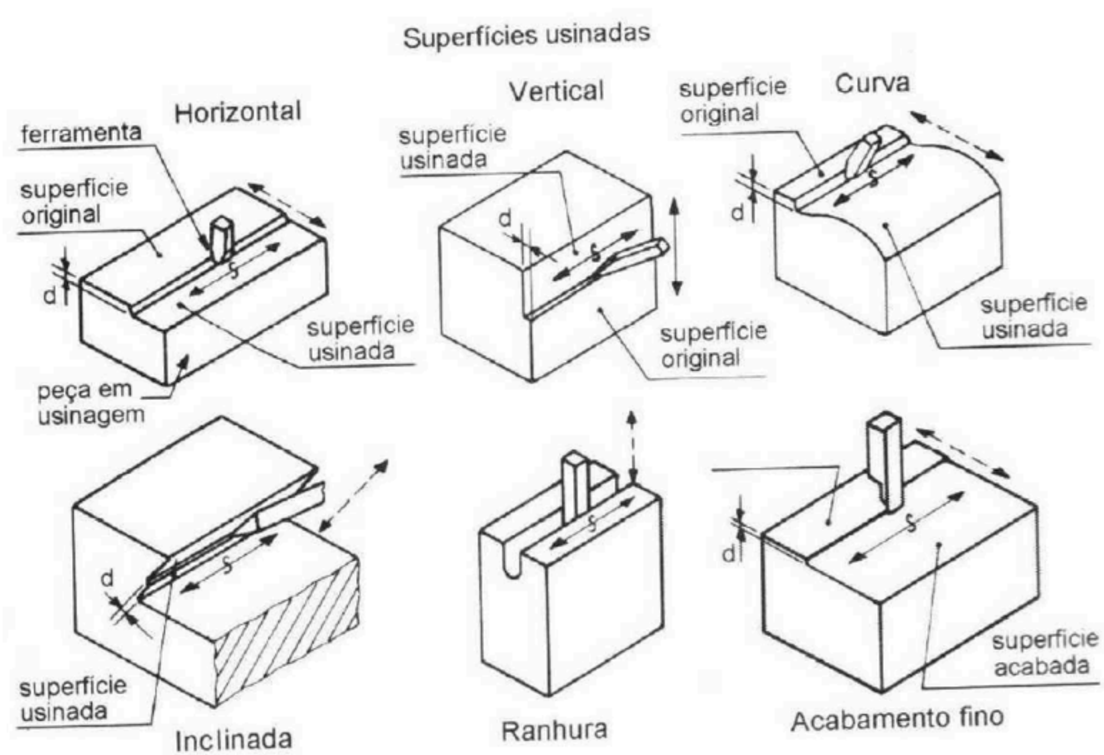
Prof. Anna Carla Araujo

Lab 2 - U3 - Ferramentas Monocortantes

Aplainamento (shaping, planing, slotting)

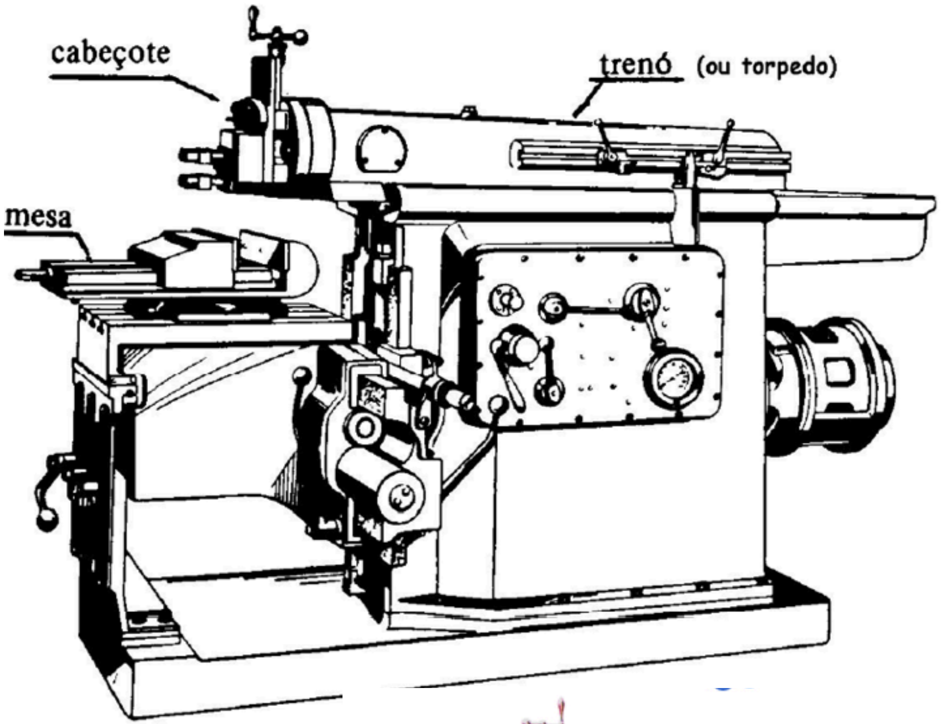
movimento principal: retilíneo alternativo

Na operação de aplainamento o corte é feito em um único sentido.
O curso útil é o movimento na direção de corte e em seguida é realizado o curso de retorno da ferramenta que é um tempo secundário necessário.Neste aspecto, esse processo é mais lento que o fresamento, por exemplo, que corta continuamente.
O volume de cavaco removido por unidade de tempo é menor no aplainamento que no fresamento.Por outro lado, a ferramenta de corte usada no aplainamento é mais barata, fácil de afiar e montar.

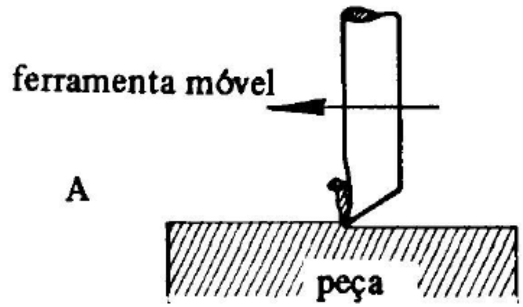


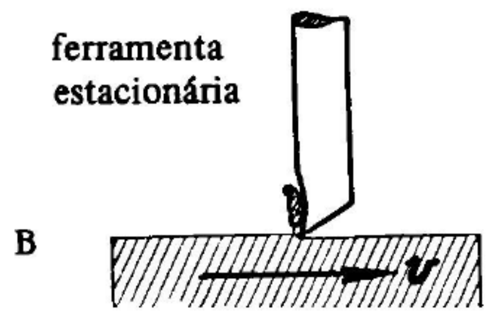
Usinagem de superfícies planas, rebaixos, perfis, cunhas, rasgos de chavetas.

Máquina-Ferramenta - a plaina



Plaina Limadora

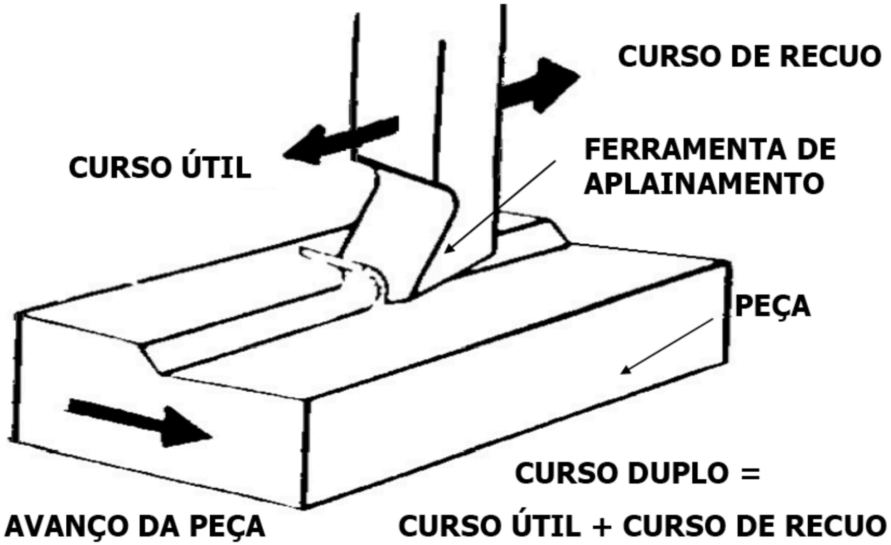


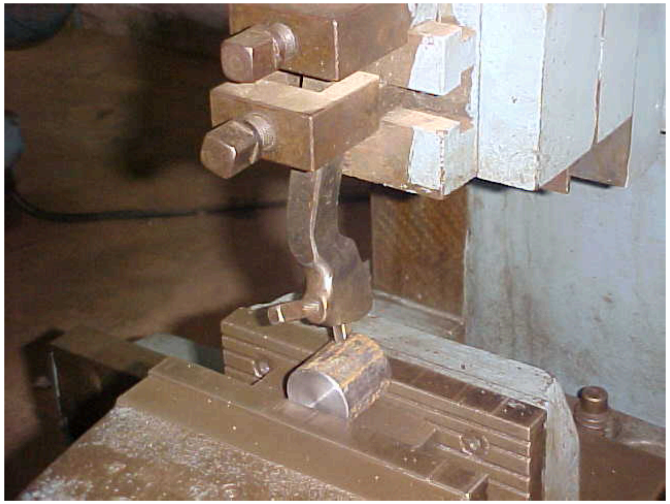


Plaina de mesa

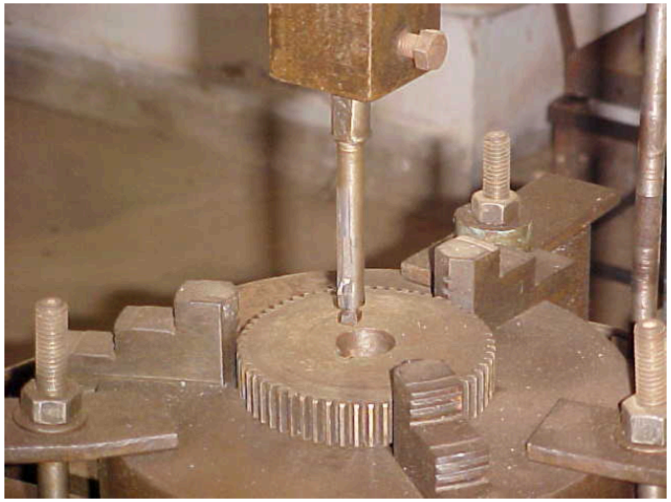
Figuras retiradas do curso de "Pratica de Oficina" do Prof. Renato Molina da Silva PUC/RS

Movimento da Ferramenta Monocortante



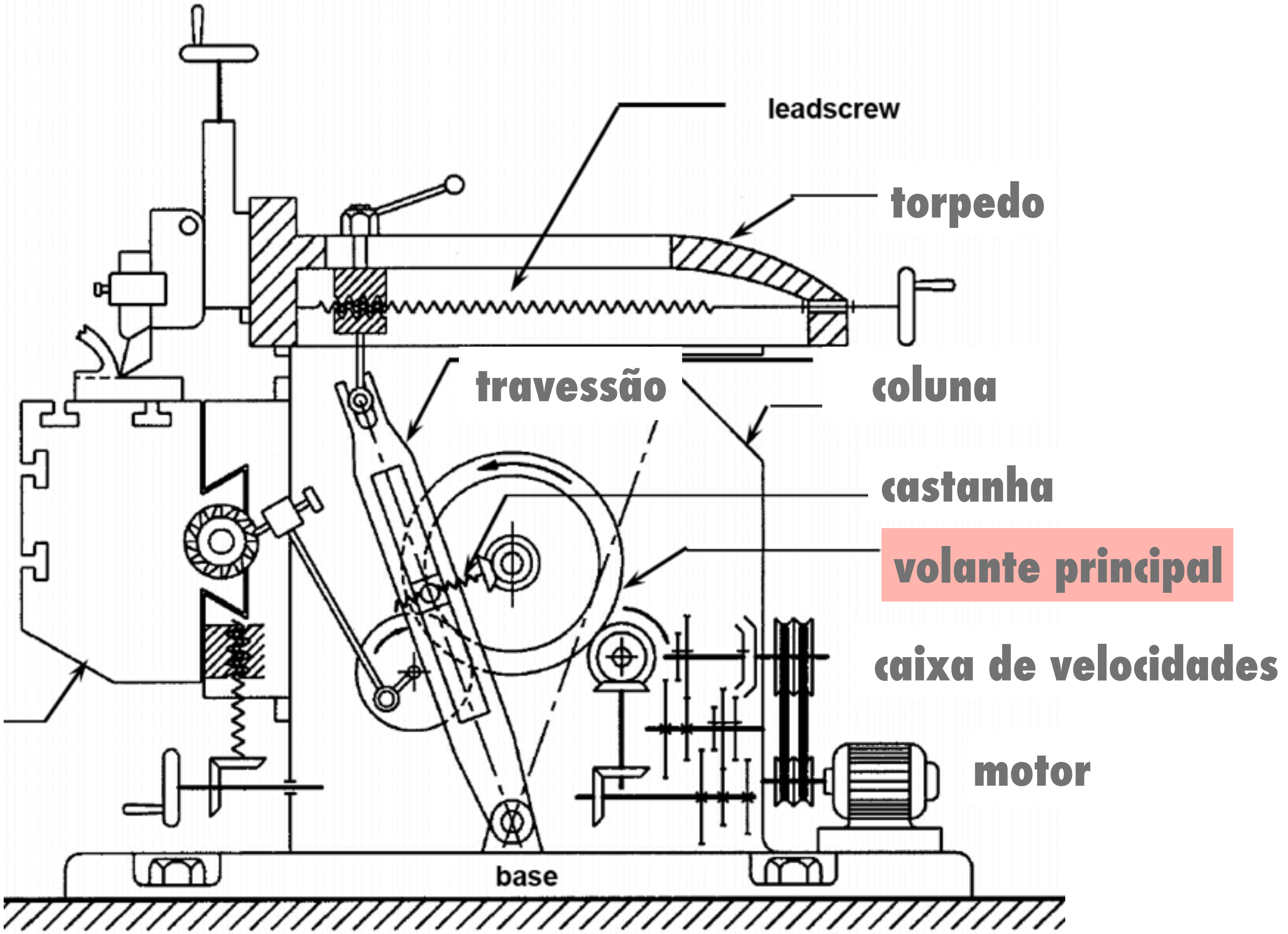


Rasgo de Chaveta
(Mov. Horizontal)

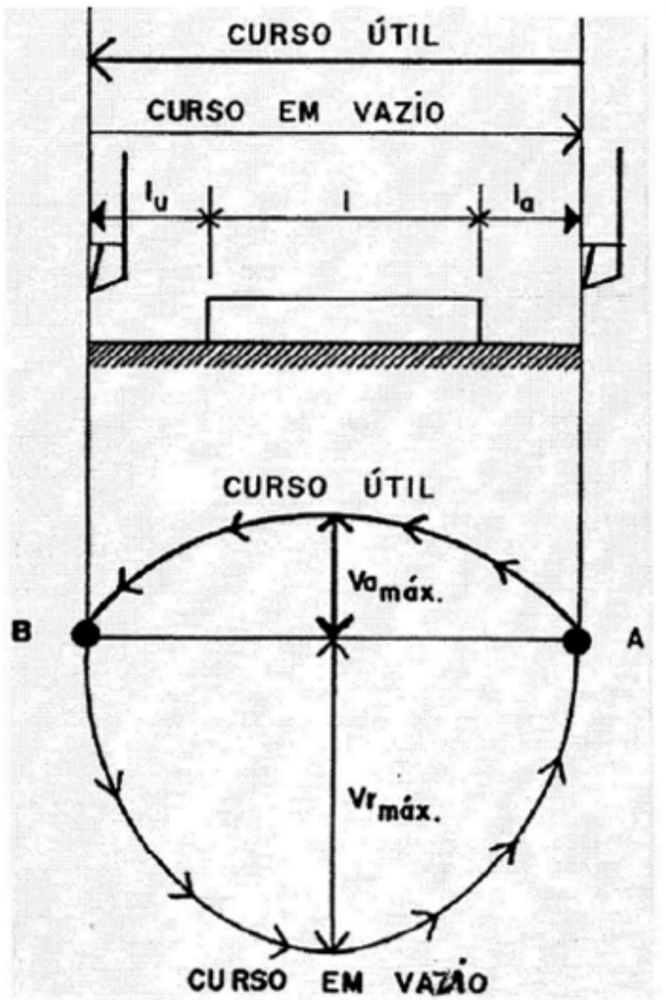


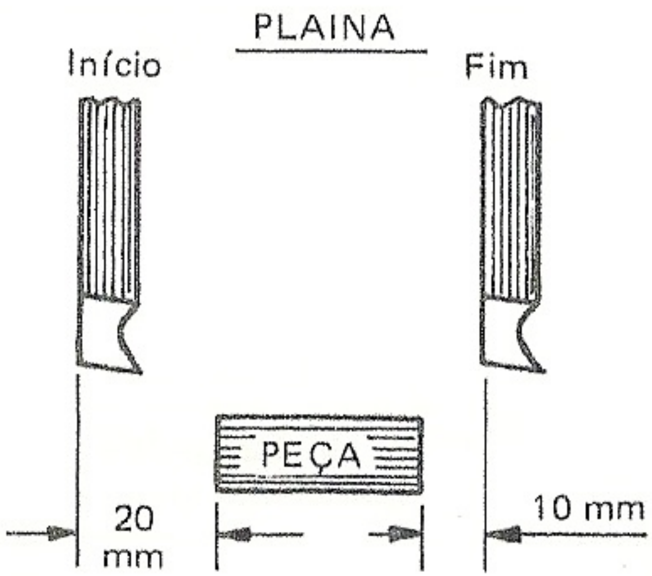
Rasgo de Chaveta
(Mov. Vertical)

O movimento de rotação dado pelo motor é transformado em movimento retilíneo alternativo do torpedo através do mecanismo de barras.



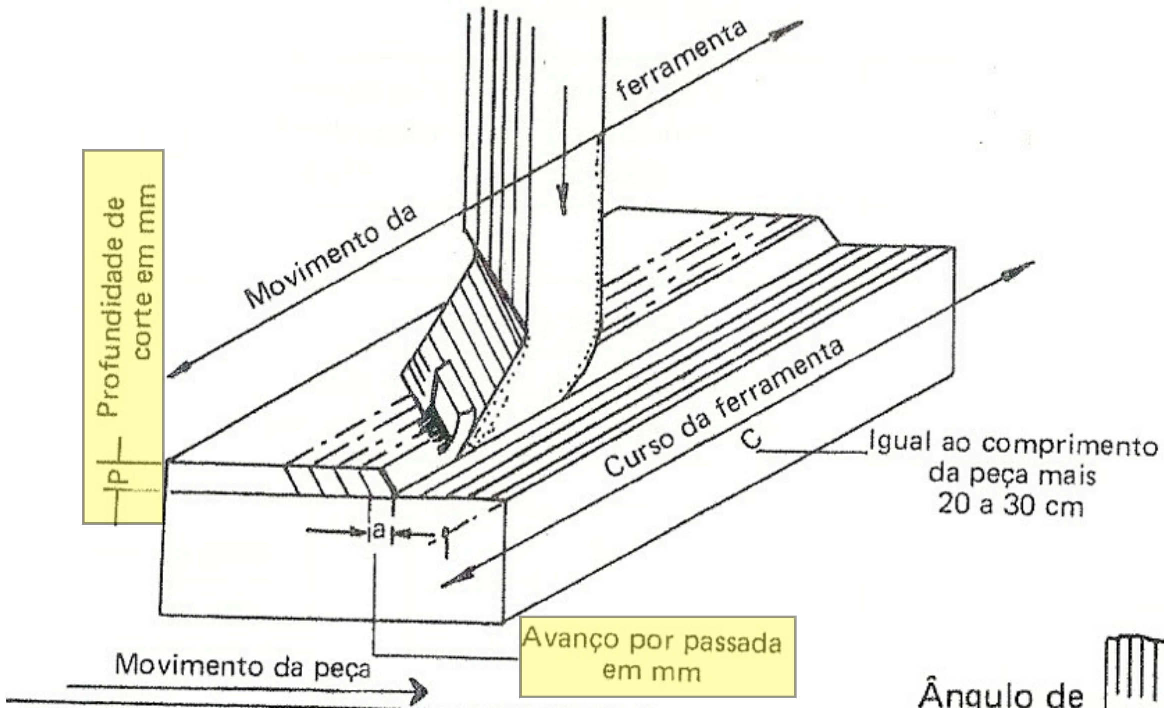
Velocidade de corte média: velocidade média, em m/min, realizada pela ferramenta durante o curso curso útil

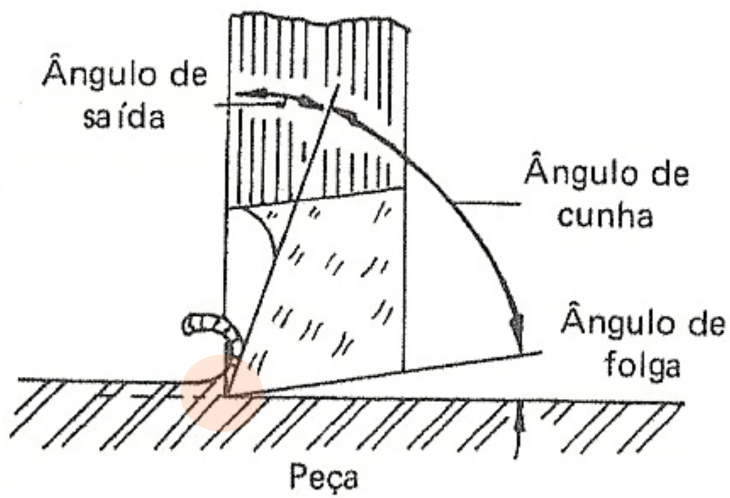




Figuras retiradas do curso de "Pratica de Oficina" do Prof. Renato Molina da Silva PUC/RS

Variáveis de Corte





Como dimensionar a profundidade e avanço?

Força = Pressão Esp. x Area de corte

(usinagem 1)
Consultar Tabela de acordo com o material da peça e da ferramenta

prof.corte . avanço

Potência = Força x Velocidade de Corte

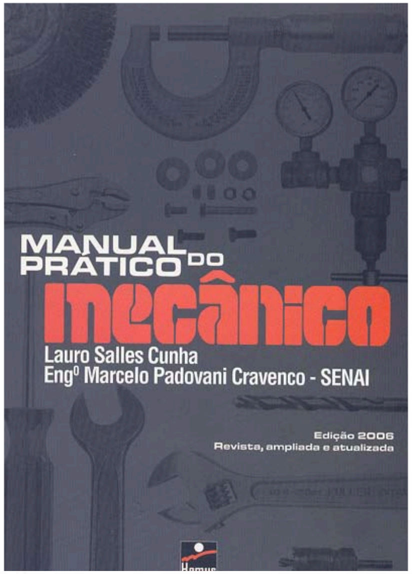
Consultar tabela para definir na máquina

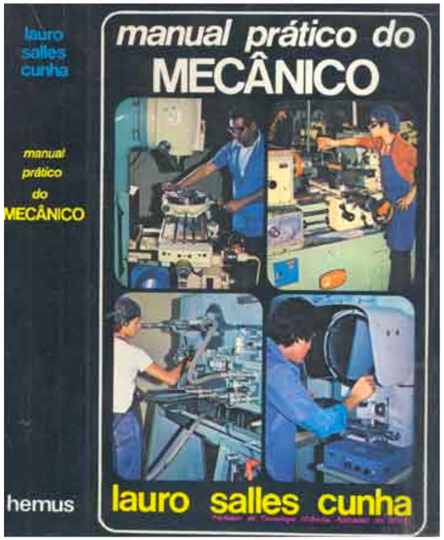
Tabelas (diferentes fontes de consulta)

Tabela 48

NORMA PARA VELOCIDADE DE CORTE E AVANÇO PARA PLAINA LIMADORA

Materiais	Ferramentas: Aço carbono		Aço rápido		Metal duro
	Vc m/min	Avanço mm	Vc m/min	Avanço mm	Vc m/min
Aço fundido	5 a 10	0,1 a 8,0	10 a 25	0,2 a 12	15 a 70
Aço doce 35 a 60 kg/mm²	6 a 12	0,1 a 8,0	10 a 30	0,2 a 12	20 a 100
Ferro fundido	5 a 8	0,1 a 8,0	10 a 20	0,2 a 12	15 a 70
Aço fundido macio	5 a 10	0,1 a 8,0	5 a 10	0,2 a 12	10 a 60
Aço semi-duro (5o a 60)	5 a 10	0,1 a 8,0	12 a 15	0,2 a 12	15 a 80
Aço duro 60 a 90	5 a 10	0,1 a 15,0	10 a 12	0,2 a 12	10 a 60
Bronze	10 a 18	0,1 a 10,0	20 a 30	0,2 a 12	30 a 200
Latão	10 a 20	0,1 a 10,0	20 a 30	0,2 a 12	50 a 350
Metais leves	10 a 25	0.1 a 10,0	25 a 50	0.2 a 12	50 a 350
Cobre	10 a 25	0.1 a 10,0	25 a 50	0.2 a 12	50 a 350





Tabelas (diferentes fontes de consulta)

TABLE 4-1 Speed and Feed for Planers

Work material	Type of tool					
	High-speed steel		Cast alloys		Carbides	
	Speed, fpm	Max feed, in	Speed, fpm	Max feed, in	Speed, fpm	Max feed, in
Aluminum	200–300	0.125	*	*	†	0.125
Brass (soft)	150–250	0.250	*	*	†	0.125
Bronze (medium)	75–125	0.075	*	*	150–300	0.050
Bronze (hard)	30–60	0.050	50–100	0.040	150–200	0.050
Cast iron (soft)	50–80	0.125	90–120	0.050	110–225	0.050
Cast iron (hard)	30–50	0.060	50–80	0.050	100–200	0.050
Malleable iron	50–90	0.090	80–120	0.050	150–250	0.050
Cast steel (30% C)	25–60	0.050	60–80	0.040	100–180	0.040
Steel (soft)	70–100	0.050	*	*	180–300	0.050
Steel (medium)	60–70	0.060	*	*	180–250	0.050
Steel (hard)	20–35	0.035	*	*	100–180	0.035

Note: Data based on an average depth of cut of ½ in. Speed increases up to 50 percent are frequently possible on light finishing cuts.
*This tool not recommended for this application.
†Maximum speed of the planer.

TOOL AND MANUFACTURING ENGINEERS HANDBOOK

Fourth Edition

VOLUME I
MACHINING

A reference book for manufacturing engineers, managers, and technicians

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Managing Editor

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Society of Manufacturing Engineers
One SME Drive
Dearborn, Michigan

"Tool and Manufacturing Engineers Handbook" - SME (Society of Mechanical Engineers) - 3a edição (1976)
Hoje: 4a edicao (1986)

Tabelas (diferentes fontes de consulta)

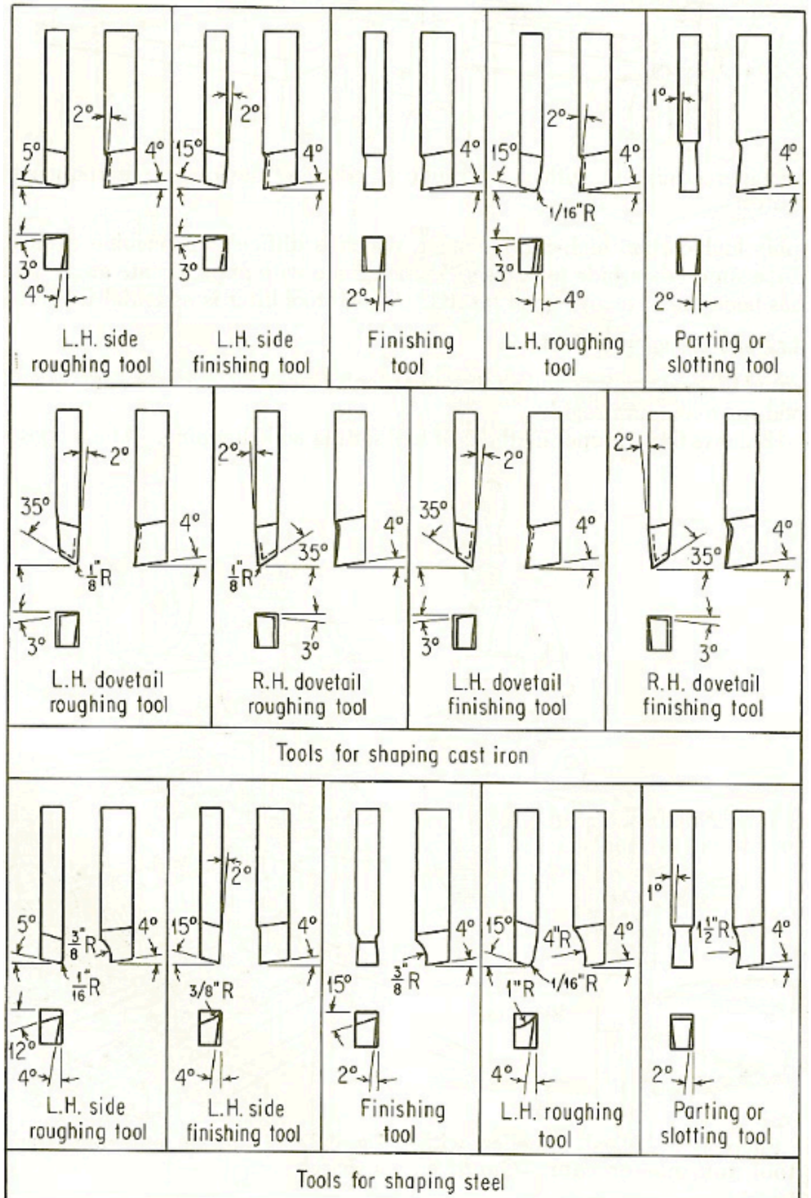
Table 1 Recommended speeds and feeds for planing with high-speed steel or carbide tools

Work metal	Hardness, HB	Depth of cut: 3.2 mm (⅛ in.) Speed, m/min (sfm)	Depth of cut: 3.2 mm (⅛ in.) Feed, mm (in.) per stroke	Depth of cut: 6.4 mm (¼ in.) Speed, m/min (sfm)	Depth of cut: 6.4 mm (¼ in.) Feed, mm (in.) per stroke	Depth of cut: 13 mm (½ in.) Speed, m/min (sfm)	Depth of cut: 13 mm (½ in.) Feed, mm (in.) per stroke	Depth of cut: 25 mm (1 in.) Speed, m/min (sfm)	Depth of cut: 25 mm (1 in.) Feed, mm (in.) per stroke	Finishing speed(a), m/min (sfm)
High-speed steel tools										
Cast iron	230	15 (50)	2.3–3.2 (0.090–0.125)	15 (50)	1.5–2.3 (0.060–0.090)	12 (40)	1.1–1.5 (0.045–0.060)	11 (35)	0.8–1.1 (0.030–0.045)	12 (40)
Cast iron	175	21 (70)	2.3–3.2 (0.090–0.125)	18 (60)	1.5–2.3 (0.060–0.090)	15 (50)	1.1–1.5 (0.045–0.060)	12 (40)	1.1–1.5 (0.045–0.060)	18 (60)
Steel	270	11 (35)	1.5–2.3 (0.060–0.090)	9 (30)	1.5–2.3 (0.060–0.090)	7.6 (25)	1.1–1.5 (0.045–0.060)	6 (20)	1.1–1.5 (0.045–0.060)	6 (20)
Steel	200	11 (35)	2.3–3.2 (0.090–0.125)	11 (35)	1.5–2.3 (0.060–0.090)	9 (30)	1.5–2.3 (0.060–0.090)	8 (25)	1.1–1.5 (0.045–0.060)	9 (30)
Steel	130	18 (60)	2.3–3.2 (0.090–0.125)	15 (50)	2.3–3.2 (0.090–0.125)	12 (40)	1.5–2.3 (0.060–0.090)	9 (30)	1.1–1.5 (0.045–0.060)	15 (50)
Bronze	Hard	18 (60)	2.3–3.2 (0.090–0.125)	18 (60)	2.3–3.2 (0.090–0.125)	15 (50)	2.3–3.2 (0.090–0.125)	12 (40)	1.5–2.3 (0.060–0.090)	18 (60)
Bronze	Soft	45 (140)	4.0–4.8 (0.156–0.188)	35 (120)	3.2–4.0 (0.125–0.156)	30 (100)	3.2–4.0 (0.125–0.156)	30 (100)	2.3–3.2 (0.090–0.125)	45 (140)
Carbide tools										
Cast iron	230	60 (200)	2.3–3.2 (0.090–0.125)	60 (200)	1.9–2.3 (0.075–0.090)	60 (200)	1.5–1.9 (0.060–0.075)	60 (200)	1.1–1.5 (0.045–0.060)	55 (180)
Cast iron	175	90 (300)	2.5–3.2 (0.100–0.125)	90 (300)	2.3–2.5 (0.090–0.100)	90 (300)	1.9–2.3 (0.075–0.090)	90 (300)	1.5–1.9 (0.060–0.075)	65 (220)
Steel	270	75 (250)	1.5–1.9 (0.060–0.075)	75 (250)	1.5–1.9 (0.060–0.075)	75 (250)	1.1–1.5 (0.045–0.060)	...	...	75 (250)
Steel	200	max	1.5–2.3 (0.060–0.090)	max	1.5–1.9 (0.060–0.075)	90 (300)	1.5–1.9 (0.060–0.075)	...	...	90 (300)
Steel	130	max	1.5–2.3 (0.060–0.090)	max	1.5–2.3 (0.060–0.090)	max	1.5–2.3 (0.060–0.090)	...	...	90 (300)
Bronze	Hard	max	2.3–3.2 (0.090–0.125)	max	2.3–3.2 (0.090–0.125)	max	2.3–2.5 (0.090–0.100)	max	1.5–2.3 (0.060–0.090)	max
Bronze	Soft	max	2.3–3.8 (0.090–0.150)	max	2.3–3.2 (0.090–0.125)	max	2.3–3.2 (0.090–0.125)	max	2.3–2.5 (0.090–0.100)	max

(a) For a depth of cut ranging from 0.08–0.38 mm (0.003–0.015 in.). Finishing feeds at these speeds depend on the type of tool used. Flat-nose tools are used for cast iron and bronze at feeds of 13–25 mm (½–1 in.) per stroke; variations of flat-nose tools are used for steel at feeds of 3.2–13 mm (⅛–½ in.) per stroke. Round-nose tools are sometimes used at feeds of 1.1–1.5 mm (0.045–0.060 in.), depending on the nose radius and on the finish desired.

ASM Metals HandBook Volume 16 - Machining Processes

Tabelas de ângulos (diferentes fontes de consulta)



SME

Tabela 45

ÂNGULOS RECOMENDADOS PARA FERRAMENTA DE PLAINA LIMADORA

Material a trabalhar	Resist. à tração kg/mm^2	âng. de cunha	âng. de saída	âng. de folga
Aço de alto teor de carbono	60 a 85	68	14	8
Aço de médio teor de carbono	50 a 60	64	18	8
Aço de baixo teor de carbono	34 a 50	62	20	8
Aço fundido	70 a 100	77	6	7
Aço fundido	50 a 70	73	9	8
Ferro fundido	duro	77	6	7
Ferro fundido	mole	72	10	8
Bronze		68	12	10
Cobre		60	22	8
Alumínio		40	40	10

Manual prático

TABLE 5-3 Recommended Angles for High-Speed-Steel Single-Point Tools*†

Material	Side-relief angle, deg	Front-relief angle, deg	Back-rake angle, deg	Side-rake angle, deg
High-speed, alloy, and high-carbon tool steels and stainless steel	7- 9 (8)	6- 8 (8)	0- 7 (0)	8-10 (8)
SAE steels:				
1020, 1035, 1040	8-10 (8)	8-10 (8)	0-12 (0)	8-12 (8)
1045, 1095	7- 9 (8)	8-10 (8)	0-12 (0)	8-12 (8)
1112, 1120	7- 9 (8)	7- 9 (8)	0-14 (0)	10-14 (10)
1314, 1315	7- 9 (8)	7- 9 (8)	0-14 (0)	10-16 (10)
1335	7- 9 (8)	7- 9 (8)	0-14 (0)	10-16 (10)
3115, 3120, 3130	7- 9 (8)	7- 9 (8)	0-10 (0)	8-12 (8)
3135, 3140	7- 9 (8)	7- 9 (8)	0-10 (0)	8-10 (8)
3250, 4140, 4340	7- 9 (8)	7- 9 (8)	0- 8 (0)	8-10 (8)
6140, 6145	7- 9 (8)	7- 9 (8)	0- 8 (0)	8-10 (8)
Aluminum	12-14 (14)	(14)	(0)	(15)
Bakelite	(14)	(14)	(0)	(10)
Brass, free-cutting	10-12 (10)	8-10 (10)	(0)	1- 8 (8)
Red, yellow, bronze—cast, bronze—commercial	8-10 (10)	8-10 (10)	(0)	−4 to +6 (+6)
Bronze, free cutting	8-10 (10)	8-10 (10)	(0)	2- 6 (6)
Hard phosphor bronze	8-10 (10)	6-10 (10)	(0)	0- 6 (6)
Cast iron, gray	8-10 (8)	6- 8 (8)	0- 5 (0)	8-12 (8)
Copper	12-14 (12)	12-14 (12)	0-16 (0)	12-20 (12)
Copper alloys:				
Hard	8-10 (10)	6-10 (10)	(0)	0- 8 (8)
Soft	10-12 (12)	8-12 (12)	0- 2 (0)	0-10 (10)
Fiber	14-16 (14)	12-14 (14)	0- 2 (0)	0-10 (10)
Formica	14-16 (14)	10-14 (14)	0-16 (0)	10-12 (12)
Nickel iron	14-16 (14)	10-14 (14)	0- 8 (0)	12-15 (15)
Micarta	14-16 (14)	10-14 (14)	0-16 (0)	10-15 (15)
Monel and nickel	14-16 (14)	12-14 (14)	0-10 (0)	12-15 (15)
Nickel silvers	10-14 (14)	10-14 (14)	0-10 (0)	0-10 (10)
Rubber, hard	18-20 (20)	14-20 (20)	(0)	0-20 (20)

* Data by Latrobe Steel Co.

† Angles in parentheses are those recommended as a preferred starting point.

Tabelas

Tabela 4.1 - Valores dos parâmetros 1-z e K_{s1} para diversos materiais

MATERIAL	σ_t (N/mm²)	1-z	K_{s1}
Aço ABNT 1030	520	0,74	1990
1040	620	0,83	2110
1050	720	0,70	2260
1045	670	0,86	2220
1060	770	0,82	2130
8620	770	0,74	2100
4320	630	0,70	2260
4140	730	0,74	2500
4137	600	0,79	2240
6150	600	0,74	2220
Ferro Fundido	HRc = 46	0,81	2060
Ferro Fundido GG26	HB = 200	0,74	1160

Diniz, 1999

Rugosidade de Superfície

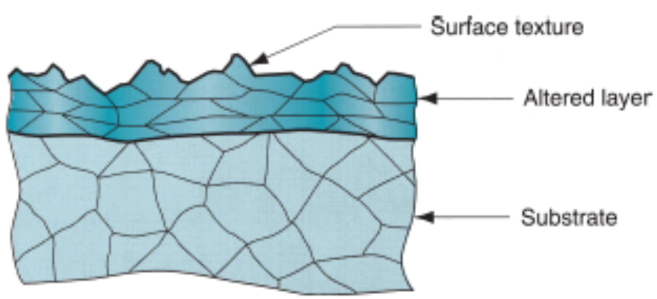


FIGURE 4.2 A magnified cross section of a typical metallic part surface. (Credit: *Fundamentals of Modern Manufacturing*, 4th Edition by Mikell P. Groover, 2010. Reprinted with permission of John Wiley & Sons, Inc.)

$$R_a = \int_0^{L_m} \frac{|y|}{L_m} dx$$

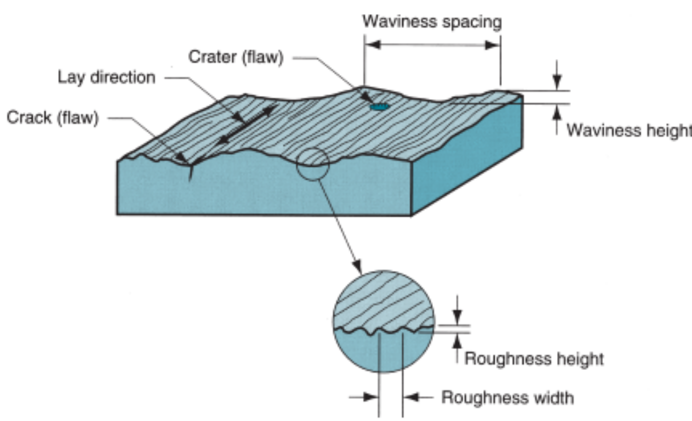
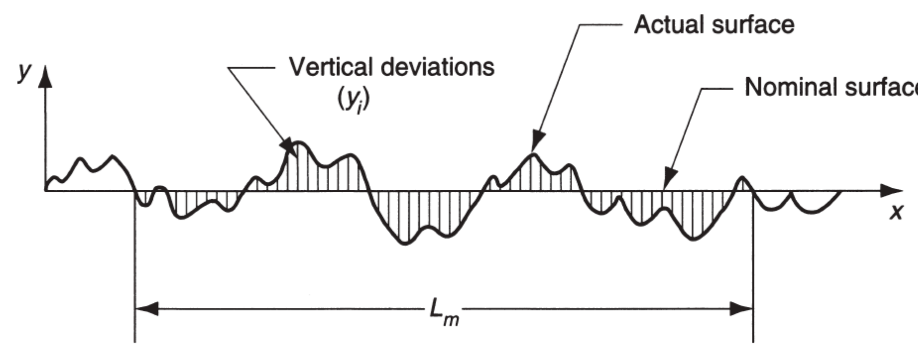
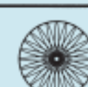
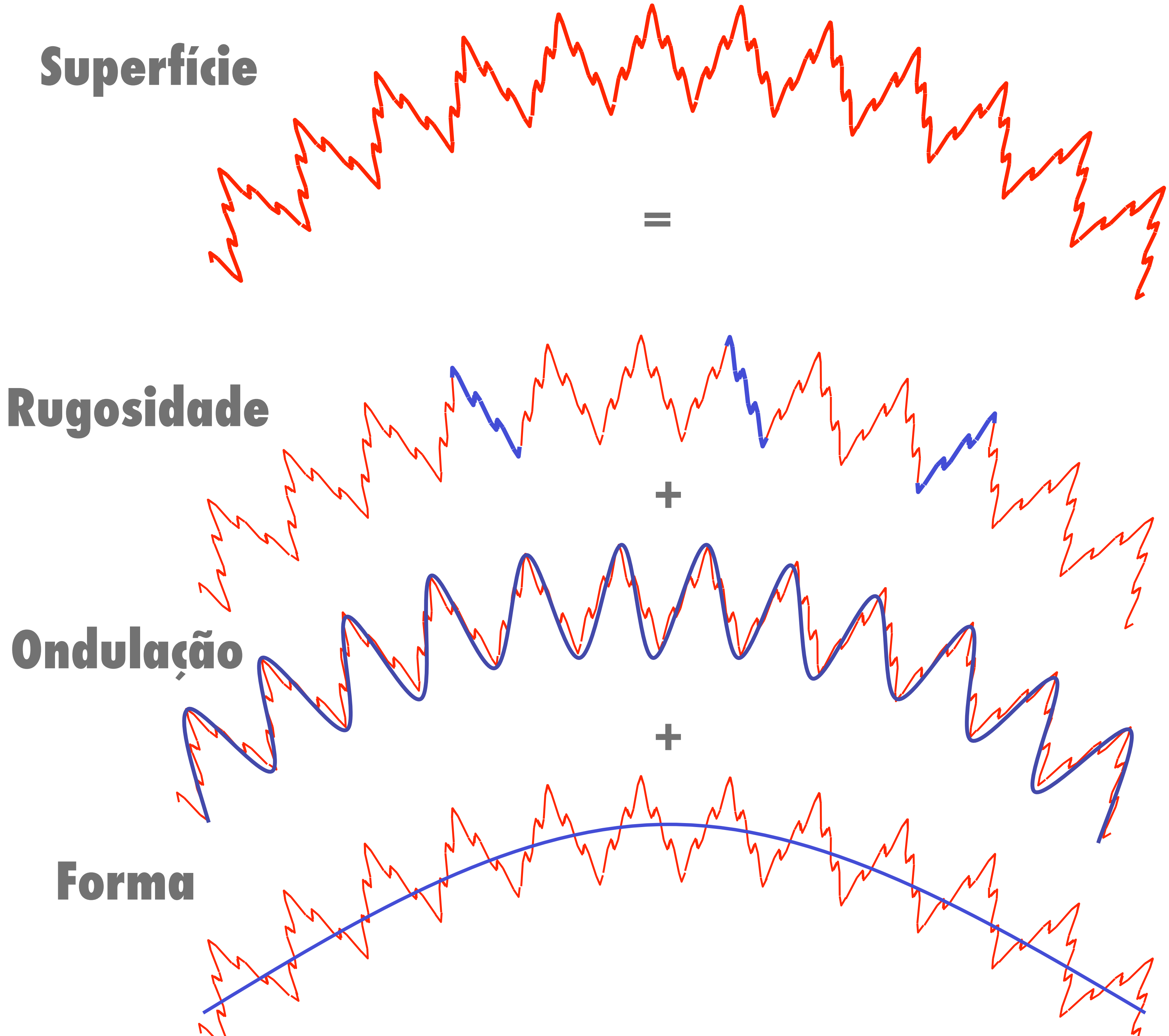


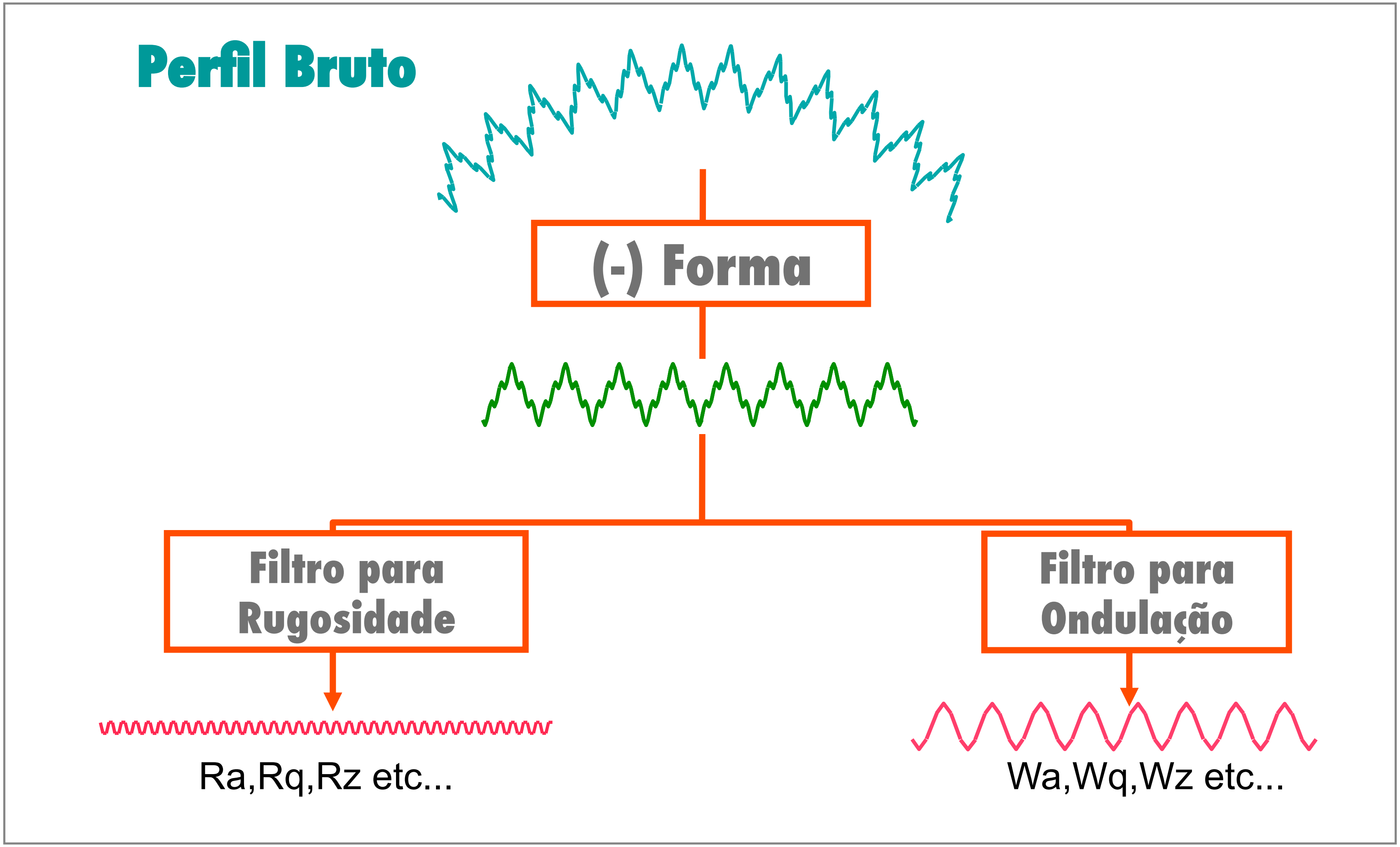
FIGURE 4.3 Surface texture features. (Credit: *Fundamentals of Modern Manufacturing*, 4th Edition by Mikell P. Groover, 2010. Reprinted with permission of John Wiley & Sons, Inc.)



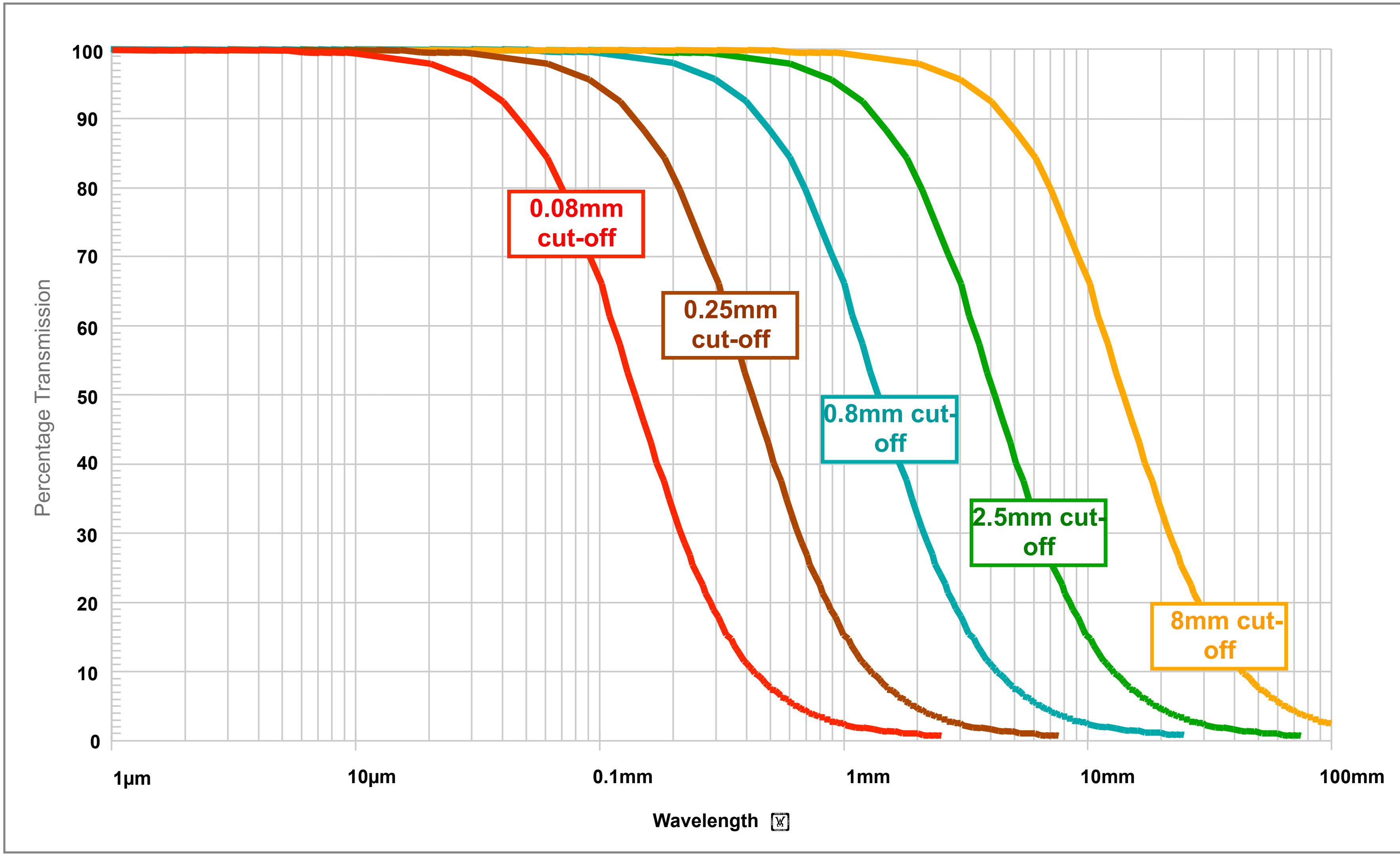
Lay symbol	Surface pattern	Description	Lay symbol	Surface pattern	Description
=		Lay is parallel to line representing surface to which symbol is applied.	C		Lay is circular relative to center of surface to which symbol is applied.
⊥		Lay is perpendicular to line representing surface to which symbol is applied.	R		Lay is approximately radial relative to the center of the surface to which symbol is applied.
X		Lay is angular in both directions to line representing surface to which symbol is applied.	P		Lay is particulate, nondirectional, or protuberant.


Superfície
=
Rugosidade
+
Ondulação
+
Forma

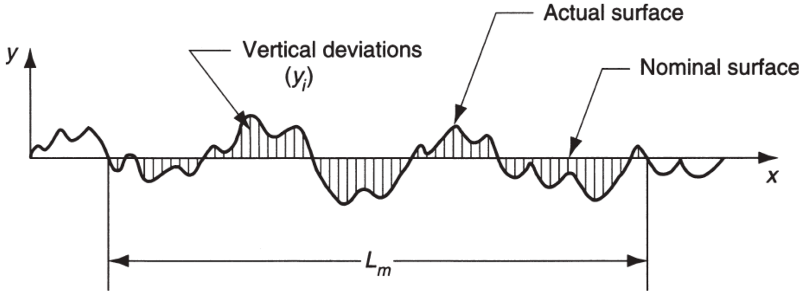
Rugosidade de Superfície



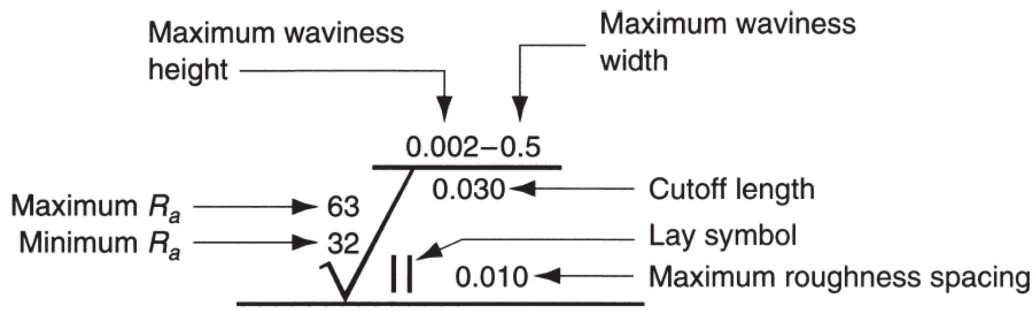
Cut-off e Filtros para Rugosidade



Rugosidade de Superfície



Cutoff

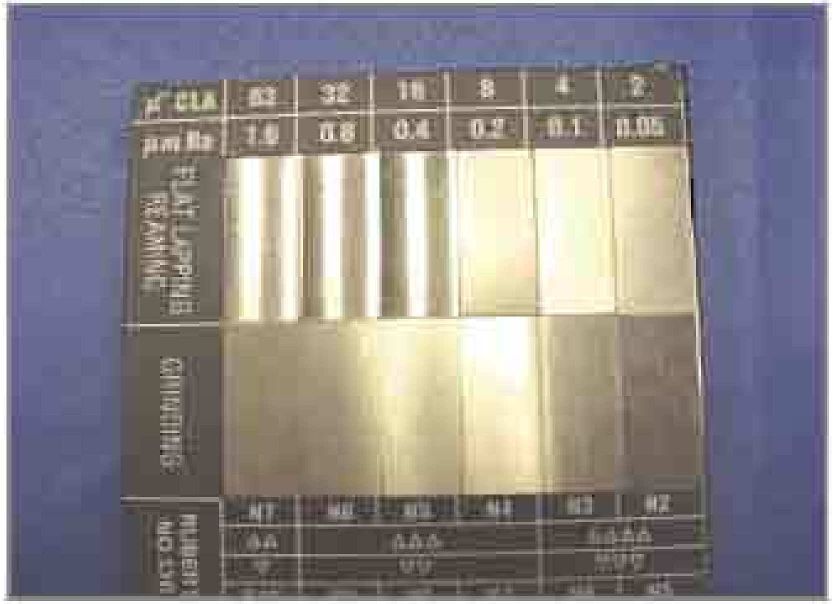


$$R_a = \sum_{i=1}^{n} \frac{|y_i|}{n}$$

TABLE 4.3 Surface roughness values produced by the various manufacturing processes.[a]

Process	Typical Finish	Roughness Range[b]	Process	Typical Finish	Roughness Range[b]
Casting:			Abrasive:		
Die casting	Good	1–2 (30–65)	Grinding	Very good	0.1–2 (5–75)
Investment	Good	1.5–3 (50–100)	Honing	Very good	0.1–1 (4–30)
Sand casting	Poor	12–25 (500–1000)	Lapping	Excellent	0.05–0.5 (2–15)
Metal forming:			Polishing	Excellent	0.1–0.5 (5–15)
Cold rolling	Good	1–3 (25–125)	Superfinish	Excellent	0.02–0.3 (1–10)
Sheet metal draw	Good	1–3 (25–125)	Nontraditional:		
Cold extrusion	Good	1–4 (30–150)	Chemical milling	Medium	1.5–5 (50–200)
Hot rolling	Poor	12–25 (500–1000)	Electrochemical	Good	0.2–2 (10–100)
Machining:			Electric discharge	Medium	1.5–15 (50–500)
Boring	Good	0.5–6 (15–250)	Electron beam	Medium	1.5–15 (50–500)
Drilling	Medium	1.5–6 (60–250)	Laser beam	Medium	1.5–15 (50–500)
Milling	Good	1–6 (30–250)	Thermal:		
Reaming	Good	1–3 (30–125)	Arc welding	Poor	5–25 (250–1000)
Shaping and planing	Medium	1.5–12 (60–500)	Flame cutting	Poor	12–25 (500–1000)
Sawing	Poor	3–25 (100–1000)	Plasma arc cutting	Poor	12–25 (500–1000)
Turning	Good	0.5–6 (15–250)			

[a]Compiled from [1], [2], and other sources.
[b]Roughness range values are given, μm (μ-in). Roughness can vary significantly for a given process, depending on process parameters.


μ" CLA 63 32 16 8 4 2
μm Ra 1.6 0.8 0.4 0.2 0.1 0.05
FLAT LAPPING REAMING
GRINDING